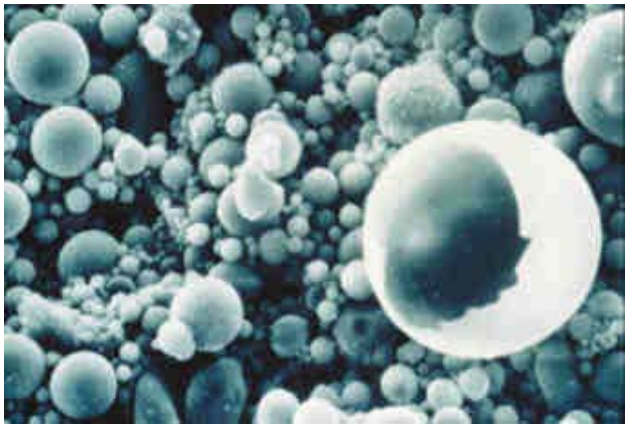

Speciation and Attenuation of Arsenic and Selenium, and Fate of Mercury in Coal Combustion Products

DOE/NETL's Mercury Control Technology R&D Program Review

Pittsburgh, PA
July 14-15, 2004

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Environment

EPRI

Technical Approach

Three Components

- Release – Field Leachate Characterization
- Transport – Attenuation Studies
- Prediction – Geochemical and Transport Modeling

Technical Approach

- **Leachate Characterization at 25 sites**
  - Analyses for broad range of inorganic analytes
  - Speciation of As, Se, and Cr
  - Speciation of Hg at 5 sites

- **Attenuation Studies of As and Se Species at 3 Sites**
  - Laboratory sorption studies on ash and soils
  - Leachate and groundwater sampling

Leachate Characterization

- **Laboratory Leaching**
  - More than 60 methodologies
    e.g., TCLP, SPLP, SGLP, ASTM, MEP, MWLP
  - Not representative of field conditions
  - Good for indexing, evaluating processes
  - Integrated Leaching Framework

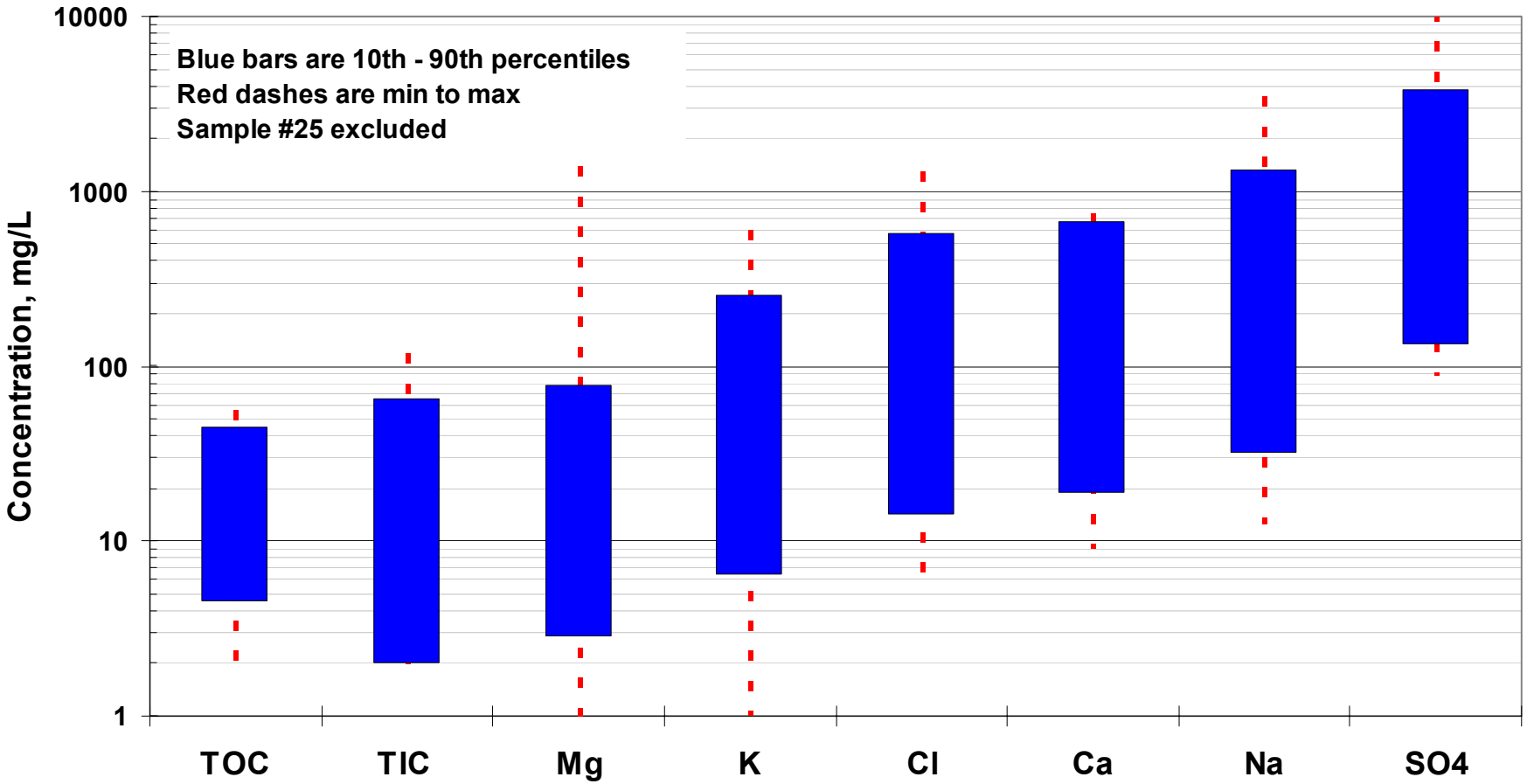
- **Field Leachate Characterization**
  - Representative of field conditions
  - Reflects variability of site conditions
    e.g., multiple fuels, heterogeneous infiltration
  - Uncontrolled, difficult to evaluate processes

Field Leachate Characterization

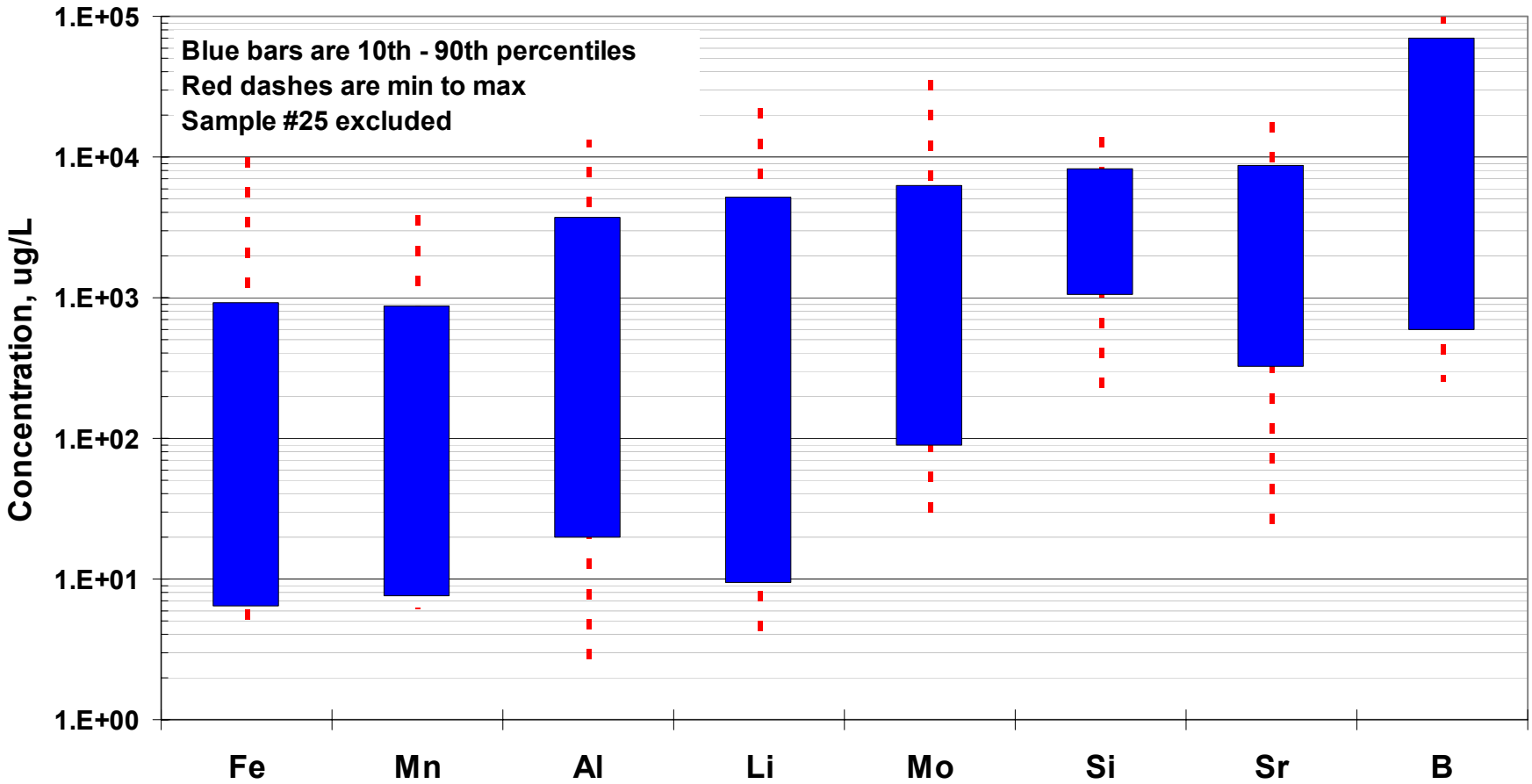
2003 Sampling Summary

- 14 Sites
  - 12 ash sites, 2 FGD sites
  - 6 ponds, 7 landfills, 1 minefill
  - 5 subbituminous, 8 bituminous, 1 mixed
- 32 Field Leachate Samples
  - wells, lysimeters, leachate collection systems, drive point, ash cores, ponds, sluice lines
- 18 Samples for Low Level Mercury
  - total Hg, monomethyl and dimethyl Hg

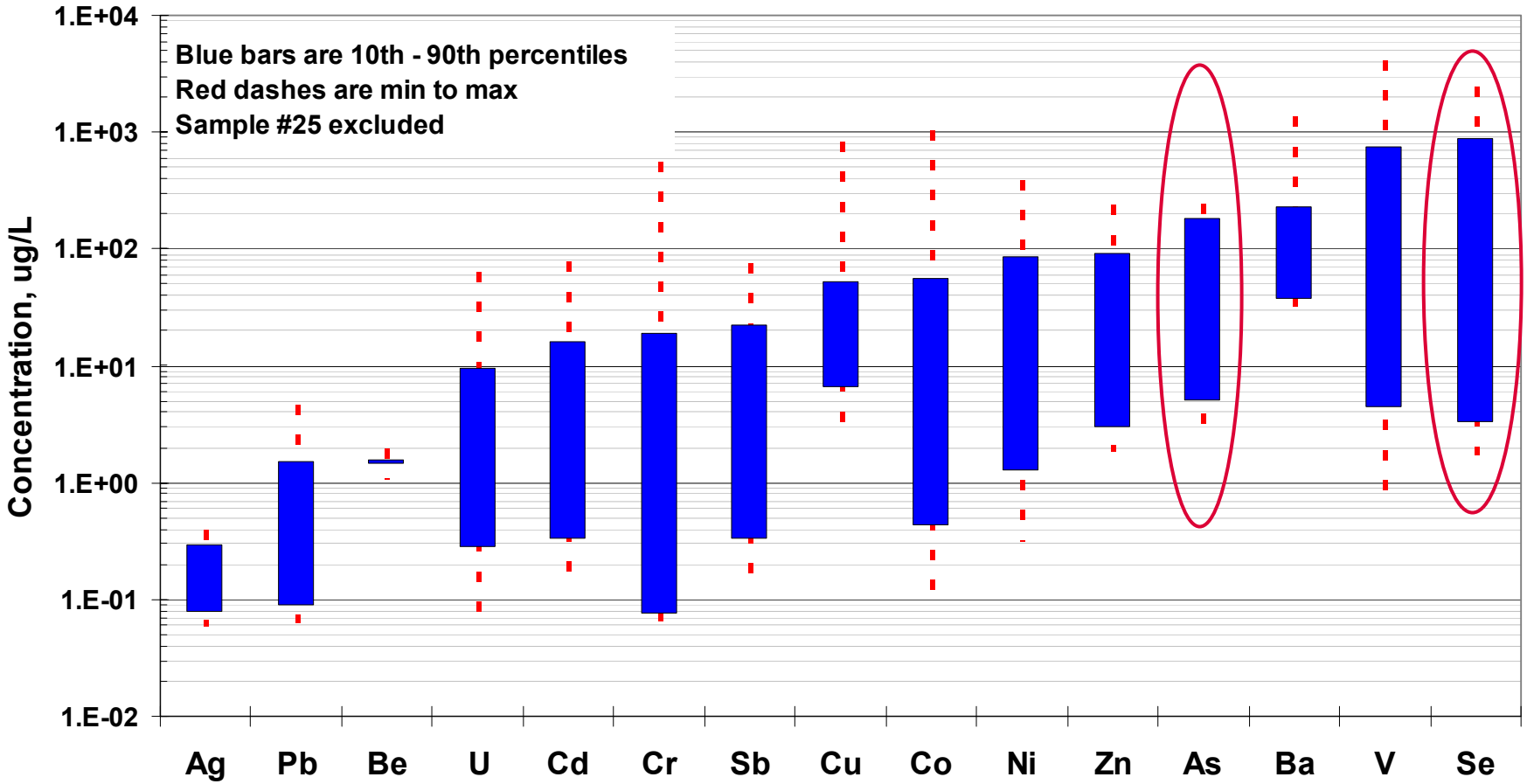
Field Leachate – Major Constituents, mg/L



Field Leachate – Minor Constituents, ug/L



Field Leachate – Trace Constituents, ug/L



Mercury

- **Lab Leaching Data**
  - Very low mercury concentrations in SPLP leachate, less than 15 ng/L
  - Lower concentrations in samples containing activated carbon

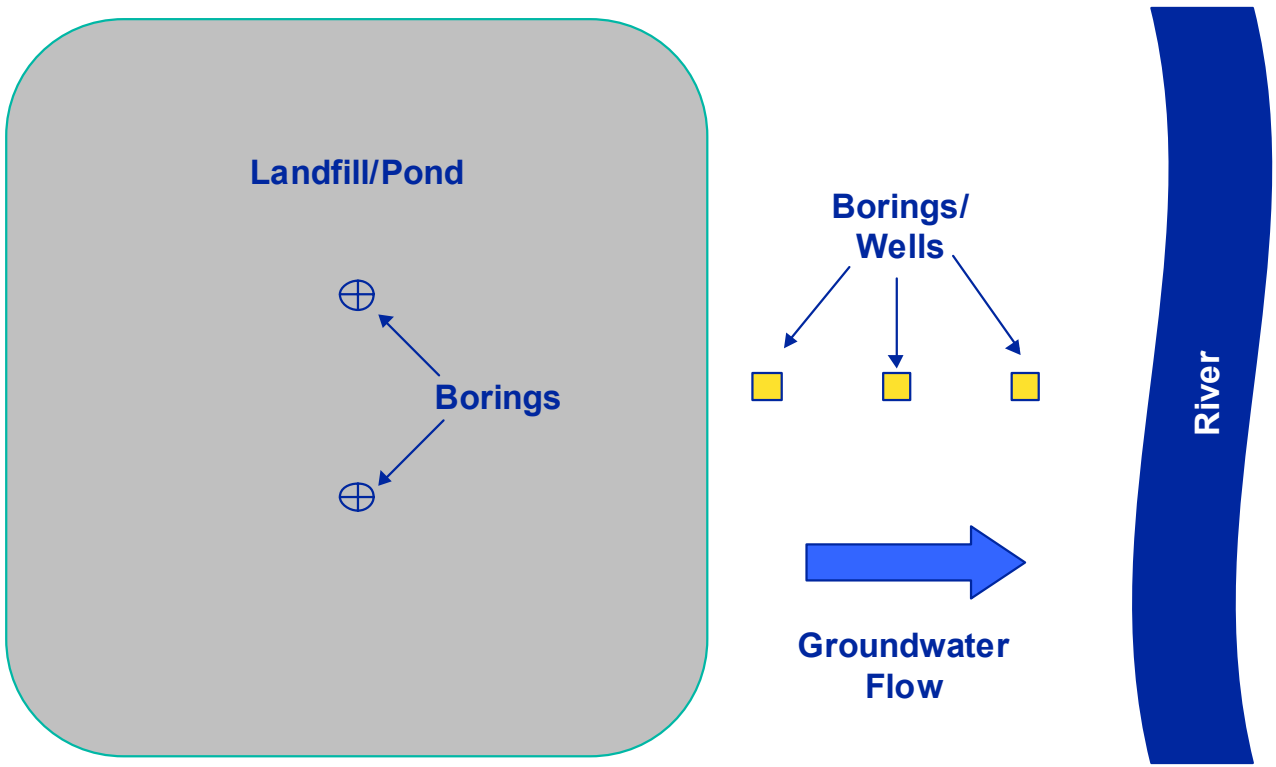
- **Preliminary Field Data**
  - Very low mercury concentrations
  - Total dissolved Hg <20 ng/L, median 2 ng/L
  - Dissolved monomethyl Hg <7 ng/L, median 0.1 ng/L
  - Dimethyl Hg not yet available

Arsenic and Selenium

- **Preliminary Leachate Data**
  - Arsenic range: 3 to 240 ug/L
  - Selenium range: 2 to 2000 ug/L
  - Both arsenic and selenium exhibit highly variable speciation
  - Possibility of increased selenium leaching from carbon injection ash (laboratory, one sample set)

Arsenic and Selenium Attenuation

Arsenic & Selenium Transport



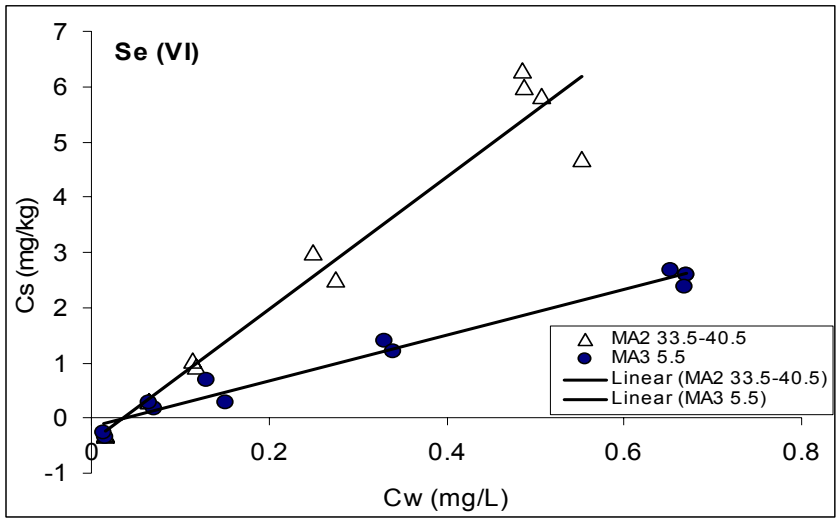
Arsenic and Selenium Attenuation

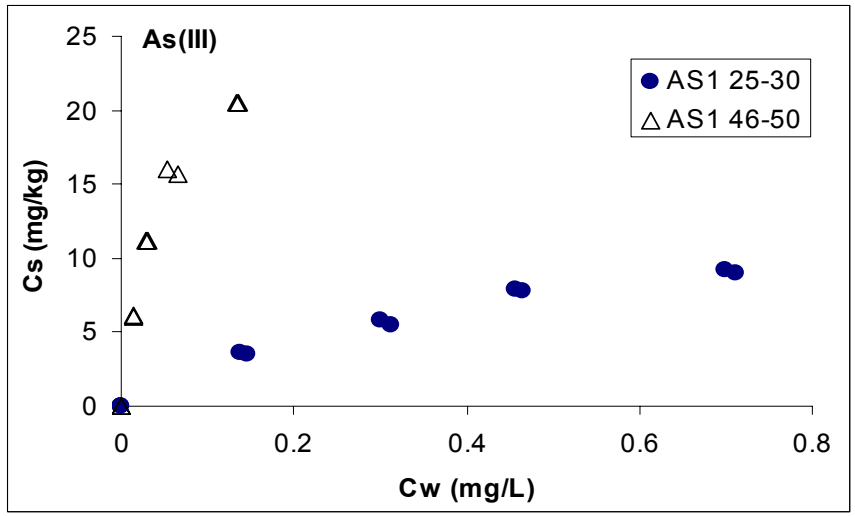
- **Ash Characterization**
  - Total Composition
  - Sequential Leaching of Ash
  - Adsorption Capacity of Ash
  - Speciation
- **Soil Characterization**
  - pH
  - Texture
  - Organic Matter
  - Total Iron and Manganese
  - Extractable Iron and Manganese (CBD Extraction)
  - CEC and AEC
  - Base Saturation
  - Clay Mineralogy (XRD)

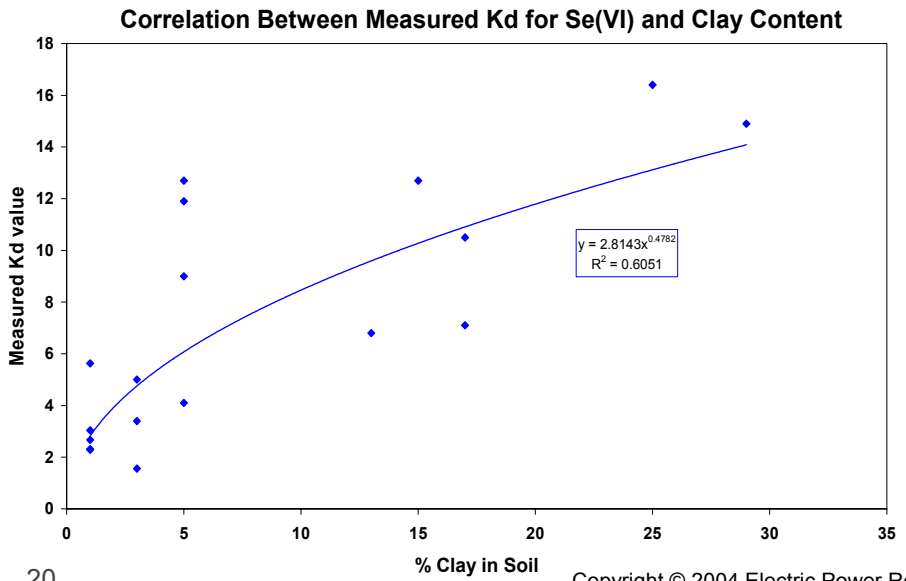
Arsenic and Selenium Attenuation

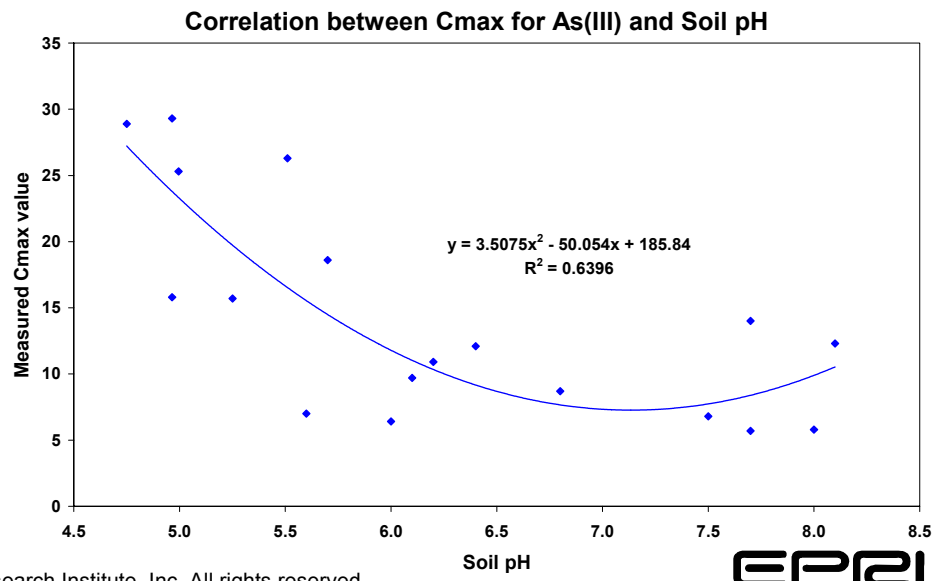
- **Batch Studies**
  - As(III), As(V), Se(IV), Se(VI)
  - 7 concentrations in leachate range (e.g., 50- 2000 ppb)
  - Single and multi-solute solutions
  - pH dependence
  - Sulfate competition
  - Leachate matrix effects
  - Reversibility
- **Column Studies**

Arsenic & Selenium Attenuation









Arsenic and Selenium Attenuation

- **Arsenic Sorption**
  - Nonlinear (concentration dependent)
  - Single point As^{+3} Kd values: 7 to 400
  - Single point As^{+5} Kd values: 15 to >1000

- **Selenium Sorption**
  - Mostly linear
  - Se^{+4} Kd values: 15 on 30
  - Se^{+6} Kd values: 1 to 16

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